



10 MAY 2002

FORM PTO-1390 (Modified) (REV 11-2000)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER 208524US3PCT	
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371				U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR <div style="text-align: right; font-size: 1.2em;"># 5</div>	
INTERNATIONAL APPLICATION NO. PCT/JP00/06518		INTERNATIONAL FILING DATE 22 September 2000		PRIORITY DATE CLAIMED 27 September 1999	
TITLE OF INVENTION BENDING APPARATUS FOR GLASS SHEET AND METHOD OF BENDING GLASS SHEET					
APPLICANT(S) FOR DO/EO/US Hiroshi YAMAKAWA, et al.					
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:					
<ol style="list-style-type: none"> 1. <input checked="" type="checkbox"/> This is a FIRST submission of items concerning a filing under 35 U.S.C. 371. 2. <input type="checkbox"/> This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371. 3. <input checked="" type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (24) indicated below. 4. <input type="checkbox"/> The US has been elected by the expiration of 19 months from the priority date (Article 31). 5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371 (c) (2)). <ol style="list-style-type: none"> a. <input type="checkbox"/> is attached hereto (required only if not communicated by the International Bureau). b. <input checked="" type="checkbox"/> has been communicated by the International Bureau. c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US). 6. <input checked="" type="checkbox"/> An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)). <ol style="list-style-type: none"> a. <input checked="" type="checkbox"/> is attached hereto. b. <input type="checkbox"/> has been previously submitted under 35 U.S.C. 154(d)(4). 7. <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3)) <ol style="list-style-type: none"> a. <input type="checkbox"/> are attached hereto (required only if not communicated by the International Bureau). b. <input type="checkbox"/> have been communicated by the International Bureau. c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired. d. <input checked="" type="checkbox"/> have not been made and will not be made. 8. <input type="checkbox"/> An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)). 9. <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)). 10. <input type="checkbox"/> An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)). 11. <input type="checkbox"/> A copy of the International Preliminary Examination Report (PCT/IPEA/409). 12. <input checked="" type="checkbox"/> A copy of the International Search Report (PCT/ISA/210). 					
Items 13 to 20 below concern document(s) or information included:					
<ol style="list-style-type: none"> 13. <input type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98. 14. <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included. 15. <input checked="" type="checkbox"/> A FIRST preliminary amendment. 16. <input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment. 17. <input type="checkbox"/> A substitute specification. 18. <input type="checkbox"/> A change of power of attorney and/or address letter. 19. <input type="checkbox"/> A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825. 20. <input type="checkbox"/> A second copy of the published international application under 35 U.S.C. 154(d)(4). 21. <input type="checkbox"/> A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4). 22. <input type="checkbox"/> Certificate of Mailing by Express Mail 23. <input checked="" type="checkbox"/> Other items or information: <div style="margin-left: 20px;"> <p>PCT/IB/304 Notice of Priority</p> <p>PCT/IB/308</p> <p>Drawings (5 Sheets)</p> <p>Request for Consideration of Documents Cited in the International Search Report</p> </div> 					

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR		INTERNATIONAL APPLICATION NO. PCT/JP00/06518		ATTORNEY'S DOCKET NUMBER 208524US3PCT	
24. The following fees are submitted: BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) : <input type="checkbox"/> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$1000.00 <input checked="" type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$860.00 <input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$710.00 <input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$690.00 <input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00 ENTER APPROPRIATE BASIC FEE AMOUNT =				CALCULATIONS PTO USE ONLY	
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).				\$0.00	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	22 - 20 =	2	x \$18.00	\$36.00	
Independent claims	2 - 3 =	0	x \$80.00	\$0.00	
Multiple Dependent Claims (check if applicable). <input type="checkbox"/>				\$0.00	
TOTAL OF ABOVE CALCULATIONS =				\$896.00	
<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27). The fees indicated above are reduced by 1/2.				\$0.00	
SUBTOTAL =				\$896.00	
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).				\$0.00	
TOTAL NATIONAL FEE =				\$896.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable). <input type="checkbox"/>				\$0.00	
TOTAL FEES ENCLOSED =				\$896.00	
				Amount to be refunded	\$
				charged	\$
a. <input checked="" type="checkbox"/> A check in the amount of <u>\$896.00</u> to cover the above fees is enclosed. b. <input type="checkbox"/> Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees. A duplicate copy of this sheet is enclosed. c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. <u>15-0030</u> A duplicate copy of this sheet is enclosed. d. <input type="checkbox"/> Fees are to be charged to a credit card. WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.					
NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.					
SEND ALL CORRESPONDENCE TO:					
Telephone Number: 703-413-3000 Fax Number: 703-413-2220			Surinder Sachar Registration No. 34,423		
 22850			SIGNATURE  C. Irvin McClelland NAME 21,124 REGISTRATION NUMBER DATE <u>May 9 2002</u>		

09/831913
531 Rec'd PCT/PTT 25 MAY 2001

208524US3PCT

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF:

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HIROSHI YAMAKAWA

: ATTN: APPLICATION DIVISION

SERIAL NO: NEW U.S. PCT APPLN
(Based on PCT /JP00/06518)

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FILED: HERewith

: EXAMINER:

FOR: BENDING APPARATUS FOR
GLASS SHEET AND METHOD OF
BENDING GLASS SHEET

:

PRELIMINARY AMENDMENT

ASSISTANT COMMISSIONER FOR PATENTS
WASHINGTON, D.C. 20231

SIR:

Prior to a first examination on the merits, please amend the above-identified application as follows:

IN THE CLAIMS

Please amend the claims as follows:

3. (Amended) The bending apparatus for at least one glass sheet according to Claim 1, wherein the second group of heating elements are suspended from a ceiling inner wall of the heating furnace at a position opposed to the upper surface of the glass sheet.

4. (Amended) The bending apparatus for at least one glass sheet according to Claim 1, wherein a distance between the second group of heating elements and the inner wall surface of the heating furnace is variable.

5. (Amended) The bending apparatus for at least one glass sheet according to Claim 1, wherein each heating element of the second group of heating elements has a heater wire and an equally heating plate provided at the heating face side of the heater wire.

8. (Amended) The method of bending at least one glass sheet according to Claim 6, wherein the second group of heating elements are suspended from a ceiling inner wall of the heating furnace and disposed at a position opposed to the upper surface of the glass sheet to provide a predetermined temperature distribution on the glass sheet.

9. (Amended) The method of bending at least one glass sheet according to Claim 6, wherein a distance between the second group of heating elements and the inner wall surface of the heating furnace is variable to provide a predetermined temperature distribution on the glass sheet.

10. (Amended) The method of bending at least one glass sheet according to Claim 6, wherein the bending mold having the glass sheet placed thereon is intermittently conveyed so as to stop at each section in the heating furnace.

Please add new Claims 11-22 as follows:

11. (New) The bending apparatus for at least one glass sheet according to Claim 2, wherein the second group of heating elements are suspended from a ceiling inner wall of the heating furnace at a position opposed to the upper surface of the glass sheet.

12. (New) The bending apparatus for at least one glass sheet according to Claim 2, wherein a distance between the second group of heating elements and the inner wall surface of the heating furnace is variable.

13. (New) The bending apparatus for at least one glass sheet according to Claim 2, wherein each heating element of the second group of heating elements has a heater wire and an equally heating plate provided at the heating face side of the heater wire.

14. (New) The method of bending at least one glass sheet according to Claim 7, wherein the second group of heating elements are suspended from a ceiling inner wall of the heating furnace and disposed at a position opposed to the upper surface of the glass sheet to provide a predetermined temperature distribution on the glass sheet.

15. (New) The method of bending at least one glass sheet according to Claim 7, wherein a distance between the second group of heating elements and the inner wall surface of the heating furnace is variable to provide a predetermined temperature distribution on the glass sheet.

16. (New) The method of bending at least one glass sheet according to Claim 7, wherein the bending mold having the glass sheet placed thereon is intermittently conveyed so as to stop at each section in the heating furnace.

17. (New) The bending apparatus for at least one glass sheet according to Claim 3, wherein a distance between the second group of heating elements and the inner wall surface of the heating furnace is variable.

18. (New) The bending apparatus for at least one glass sheet according to Claim 3, wherein each heating element of the second group of heating elements has a heater wire and an equally heating plate provided at the heating face side of the heater wire.

19. (New) The method of bending at least one glass sheet according to Claim 8, wherein a distance between the second group of heating elements and the inner wall surface of the heating furnace is variable to provide a predetermined temperature distribution on the glass sheet.

20. (New) The method of bending at least one glass sheet according to Claim 8, wherein the bending mold having the glass sheet placed thereon is intermittently conveyed so as to stop at each section in the heating furnace.

21. (New) The bending apparatus for at least one glass sheet according to Claim 4, wherein each heating element of the second group of heating elements has a heater wire and an equally heating plate provided at the heating face side of the heater wire.

22. (New) The method of bending at least one glass sheet according to Claim 9, wherein the bending mold having the glass sheet placed thereon is intermittently conveyed so as to stop at each section in the heating furnace.

Please replace the Abstract with the following amended Abstract:

ABSTRACT OF THE DISCLOSURE

A desired temperature distribution is efficiently formed on a glass sheet by a simple structure without lowering heat efficiency within a furnace. A heating furnace conveys a bending mold of a glass sheet and a radiation-heating device is provided in the heating furnace. A first group of a plurality of heating elements are fixed on an inner wall surface of the heating furnace. A second group of a plurality of heating elements are disposed separably from an inner wall surface of the heating furnace.

[illegible]

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Respectfully submitted,

Sumudu Lachar

[illegible]

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25 MAY 2001

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Marked-Up Copy
Serial No: _____
Amendment Filed on: _____

IN THE CLAIMS

Please amend the claims as follows:

- 3. (Amended) The bending apparatus for at least one glass sheet according to Claim 1[or 2], wherein the second group of heating elements are suspended from a ceiling inner wall of the heating furnace at a position opposed to the upper surface of the glass sheet.
4. (Amended) The bending apparatus for at least one glass sheet according to Claim 1, [2 or 3,] wherein a distance between the second group of heating elements and the inner wall surface of the heating furnace is variable.
5. (Amended) The bending apparatus for at least one glass sheet according to Claim 1, [2, 3 or 4,] wherein each heating element of the second group of heating elements has a heater wire and an equally heating plate provided at the heating face side of the heater wire.
8. (Amended) The method of bending at least one glass sheet according to Claim 6[or 7], wherein the second group of heating elements are suspended from a ceiling inner wall of the heating furnace and disposed at a position opposed to the upper surface of the glass sheet to provide a predetermined temperature distribution on the glass sheet.
9. (Amended) The method of bending at least one glass sheet according to Claim 6, [7 or 8,] wherein a distance between the second group of heating elements and the inner wall surface of the heating furnace is variable to provide a predetermined temperature distribution on the glass sheet.
10. (Amended) The method of bending at least one glass sheet according to Claim 6, [7, 8 or 9,] wherein the bending mold having the glass sheet placed thereon is intermittently conveyed so as to stop at each section in the heating furnace.--

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Claims 11-22 (New).

IN THE ABSTRACT

ABSTRACT OF THE DISCLOSURE

A desired temperature distribution is efficiently formed on a glass sheet by a simple structure without lowering heat efficiency within a furnace. A heating furnace [15] conveys a bending mold [9] of a glass sheet and a radiation-heating device is provided in the heating furnace[, and a] —A first group of a plurality of heating elements are fixed on an inner wall surface of the heating furnace [15[, and a] —A second group of a plurality of heating elements are disposed separably from an inner wall surface of the heating furnace.

DESCRIPTION

BENDING APPARATUS FOR GLASS SHEET AND METHOD OF BENDING
GLASS SHEET

TECHNICAL FIELD

5 The present invention relates to a bending apparatus
for at least one glass sheet to bend a glass sheet into a
desired shape at a high accuracy and a method of bending
at least one glass sheet.

BACKGROUND ART

10 When bend-forming a window glass for an automobile,
at least one glass sheet cut into a predetermined size
and shape is placed on a ring-like bending mold, and is
stayed in a plurality of heating sections for a
predetermined time in a bending zone of a heating
15 furnace, and is conveyed into the next heating section in
order, and is heated to a bending temperature (usually
about 550 to 650°C) of at least one glass sheet. Thus,
the glass sheet is bended in accordance with the shape of
the bending mold by self-weight.

20 In such a bending process of at least one glass
sheet, it is necessary for obtaining a desired shape to
accurately control a temperature distribution of the
glass sheet at a high reproducibility. When at least one
glass sheet is bended under a uniform temperature
25 condition by placing on a ring-like bending mold, it is
known that the central part of the glass sheet between
frame parts at both ends of the bending mold sags and the

sectional shape of the central line of the glass sheet becomes a flat pan bottom shape at the sagged part, or becomes a shape, the central part of which is somewhat lifted. In order to make a shape of aimed design, it is
5 necessary to maintain the peripheral zone of the glass sheet at a low temperature and the central part of the glass sheet at a high temperature, thereby forming a trapezoidal temperature distribution.

In a bending process of a glass sheet, it is known
10 to form a temperature distribution on a glass sheet. For example, it is known to employ a method of placing a locally heating device faced to the side portions of a glass sheet in order to locally largely bend the side portions of the glass sheet. However, to locally heat
15 the side portions of a glass sheet is a technical idea different from locally heating the central portion other than deformed portions in order to prevent deformation of the peripheral portion of the glass sheet.

On the other hand, there is known a glass molding
20 apparatus provided with a heat-shielding plate to shield a bending mold for placing at least one glass sheet from heat in order to obtain such a temperature distribution as to make the temperature of the central part higher than the temperature on both ends of the glass sheet as
25 mentioned above.

DISCLOSURE OF THE INVENTION

However, this conventional molding apparatus

provided with a heat-shielding plate is so complicated in respect of its structure as to disturb automatic conveyance of at least one glass sheet. Further, since the heat-shielding plate is fixed to a bending mold, a tensile stress is produced during cooling step in a zone of at least one glass sheet-placed portion of right above the heat-shielding plate, thereby lowering a strength of the glass sheet. Also, since the heat-shielding plate has a heat capacity which becomes a load to heating, it is hard to heat the whole within a furnace to such a high temperature as to be required for bending because heating energy is not efficiently used. As this result, a time required for bending is increased, and productivity is lowered.

In order to solve such a problem, JP-A-7-277754 proposes a method for obtaining a desired temperature distribution by providing a shield at appropriate position and height between heating elements, thereby limiting a heating range of the heating elements.

However, this method requires many shields to be provided depending on shapes of individual products, and is therefore hardly widely usable. Also, it is necessary to move many shields up and down respectively independently depending on the shapes of products, and it is therefore necessary to provide a plurality of elevating mechanisms which make the total structure very complicated. Also, in such a case, to provide shields

5 The present invention has been made by taking the
above conventional techniques into consideration, and an
object of the present invention is to provide a bending
apparatus of simple structure capable of efficiently
forming at least one glass sheet into a desired shape at
10 a high accuracy by forming a satisfactory temperature
distribution on the glass sheet without lowering heat
efficiency within a furnace.

Further, the present invention provides a method of
25 bending at least one glass sheet into a desired shape,
which comprises placing at least one glass sheet on a
bending mold, introducing the glass sheet placed on the

bending mold into a heating furnace having a tunnel-shaped inside, and heating the glass sheet by two types of heating means of a first group of a plurality of heating elements fixed on an inner wall surface of the heating furnace and a second group of a plurality of heating elements placed separably from the inner wall surface of the heating furnace.

According to this structure, the whole part within the heating furnace can be maintained at a satisfactory heat-bending temperature by a first group of heating elements, and at least one glass sheet can be efficiently heated from a position closer to the glass sheet separated from the inner wall surface of the furnace by a second group of heating elements. Thus, by efficiently using each heating element, its heating energy can be used efficiently for bending the glass sheet without loss.

In this case, the first group of heating elements are fixed and supported at the ceiling side or floor side of the heating furnace by means of an appropriate mounting plate or supporting bracket or the like, and are thus firmly fixed on the inner wall surface of the furnace to provide a heating device. On the other hand, the second group of heating elements constitutes a separate heating device separated from the inner wall surface of the heating furnace.

A preferable structure example includes the second

group of heating elements which radiation-heat locally a predetermined position of at least one glass sheet to provide a predetermined temperature distribution on the glass sheet.

5 According to this structure, the whole part within a furnace is heated by the first group of heating elements, and at least one glass sheet is locally heated by means of the second group of heating elements placed at a position closer to the glass sheet than the first group
10 of heating elements to form a required satisfactory temperature distribution on the glass sheet. By this manner, at least one glass sheet can be locally heated by efficiently using heat energy to provide a desired temperature distribution on the glass sheet.

15 The second group of heating elements are composed of a plurality of heating elements, each of which can control its heating temperature, and the second group of heating elements can be placed close to at least one glass sheet in such a manner as to form a desired
20 temperature distribution on the glass sheet by radiation heat from each heating element (if the heating elements are placed too part from the glass sheet, the whole part of the glass sheet is uniformly heated and a satisfactory temperature distribution cannot be provided). By
25 selectively using each heating element of the second group of heating elements, a heating temperature can be controlled and a desired temperature distribution can be

provided on the glass sheet. Also, by using the second group of a plurality of divided heating elements, it is possible to adjust a temperature depending on a size of a glass sheet employed, thus enabling a wide applicability.

5 A further preferable structure example includes the second group of heating elements suspended from the ceiling inner wall of the heating furnace in such a manner as to be opposed to the upper surface of at least one glass sheet.

10 According to this structure, it is possible to place the second group of heating elements close to the glass sheet by means of a simple structure without changing the structure of a bending mold and without adversely affecting the structure or movement of the conveying
15 system.

Also, a further preferable structure example comprises the second group of heating elements placed at a variable distance from the inner wall surface of the heating furnace.

20 According to this structure, it is possible to vary a distance between at least one glass sheet and each heating element of the second group of heating elements. By this manner, it is possible to adjust a radiation-heat amount and to simply and accurately form a desired
25 temperature distribution on the glass sheet by varying a position to be locally heated and a heating temperature depending on a material or shape of the glass sheet.

Also, a further preferable structure comprises the second group of heating elements, each of which has a heater wire and an equally heating plate provided on the heating surface of the heater wire.

5 According to this structure, it is possible to accurately control a temperature by equally imparting radiation-heat from each heating element to at least one glass sheet. Thus, the heater wire constituting a heating element is not exposed to at least one glass
10 sheet but an equally heating plate is provided between the heater wire and the glass sheet. In this manner, a temperature is controlled by the surface temperature of the equally heating plate. By using the equally heating plate, an extreme local heating by the heater wire can be
15 avoided, and a desired temperature distribution can be formed on the glass sheet without damaging the glass sheet.

Also, by using such an equally heating plate, each heating element can provide a uniform temperature face,
20 and accordingly each heating element can be easily controlled by a computer and deformation analysis of at least one glass sheet can be easily made by means of finite element method, thus enabling to previously fix a temperature of each of individual heating elements.

25 As mentioned above, in order to achieve the above object, a radiation-heating device employed in the present invention comprises a first group of heating

elements fixed to an inner wall surface of a heating furnace and a second group of heating elements divided into each heating element in the vicinity of at least one glass sheet in the furnace, and a desired temperature distribution can be provided on at least one glass sheet by selectively employing each heating element or by adjusting its fixed temperature of each heating element. In such a case, the second group of heating elements for providing a temperature distribution are preferably individually divided and disposed along such a direction as to form a desired temperature distribution on at least one glass sheet. For example, when a heating device is prepared by arranging heating elements of longitudinal shape in a row and the heating device thus prepared is applied to preparation of a window glass for an automobile, heating elements are disposed so as to put the longitudinal direction of each heating element along the direction vertical to the center line of at least one glass sheet (width direction of a glass sheet) in the vicinity of the central part of the glass sheet. Also, in the central part of the side periphery, in order to control a bending depth of at least one glass sheet, the heating elements are disposed so as to put the longitudinal direction of each heating element in the direction parallel to the centerline of at least one glass sheet (see the following Figure 4).

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a general structure view illustrating a bending apparatus for at least one glass sheet employed in the present invention.

5 Figure 2 is a structure view illustrating an example of a radiation-heating device used in the present invention.

Figure 3 is a structure view illustrating another example of a radiation-heating device used in the present
10 invention.

Figure 4 is a structure view illustrating still another example of a radiation-heating device used in the present invention.

Figure 5 is a sectional view illustrating an example
15 of a radiation-heating device used in the present invention.

Figure 6 is a sectional view illustrating another example of a radiation-heating device used in the present invention.

20 Figure 7 is a structure view of the inside of a furnace illustrating an example of a bending apparatus of the present invention.

Figure 8 is a structure view of the inside of a furnace illustrating another example of a bending
25 apparatus of the present invention.

Figure 9 is a sectional view illustrating a preferable structure of a heating element used in the

present invention.

Hereinafter, the embodiments of the present invention are explained with reference to the drawings.

A tunnel-like heating furnace 1 comprises a preheating zone Z1, a bending zone Z2 and an annealing zone Z3. Each zone comprises a plurality of sections (in this example, the preheating zone comprises 4 sections, the bending zone comprises 8 sections and the annealing zone comprises 4 sections). A conveyer (not shown) is provided through the preheating zone Z1, the bending zone Z2 and the annealing zone Z3, and a bending mold (not shown) having at least one glass sheet placed thereon is conveyed through a heating furnace by the conveyer. In the bending zone Z2, a ceiling heater (not shown), a floor heater 3 and a side wall heater (not shown) are provided respectively on the ceiling, floor and side wall of the heating furnace 1. Each of the ceiling heater, the floor heater and the side wall heater comprises a plurality of heating elements fixed on an inner wall surface of the heating furnace 1 by an appropriate fixing and supporting means. These ceiling heater, floor heater and side wall heater heat the whole part within a furnace, and constitute a first group of heating elements

of the present invention.

A divided radiation-heating device 2 of the present invention is provided on the upper side of a conveyer (not shown) of each section of the bending zone Z2 in such a manner as to be separated from the ceiling inner wall of the heating furnace. The radiation-heating device 2 constitutes a second group of heating elements of the present invention.

The bending mold comprises a ring having a shape
10 curved so as to almost corresponds to an aimed bending
shape of the periphery of at least one glass sheet as the
main constituting element.

After cutting a glass sheet into a predetermined shape, one or two or more glass sheet is placed on the bending mold and heated to about 500°C in the preheating zone Z1. Thereafter, the glass sheet is heated so as to form a desired temperature distribution thereon in the bending zone Z2, and is bended into a shape in conformity with the shape of the bending mold by self-weight. The glass sheet is then slowly cooled in the annealing zone Z3.

The bending mold having the glass sheet placed thereon is conveyed so as to intermittently stop at each section in the heating furnace 1. A desired temperature distribution is formed on at least one glass sheet by the radiation-heating device (second group of heating elements) of the present invention while staying in a

section in order in the bending zone Z2 in the furnace.
The temperature distribution becomes an aimed temperature
distribution when the bending mold is stayed in the final
section of the bending zone Z2, and the glass sheet is
5 bended into a desired shape by self-weight.

Figure 2 is a structure view illustrating an example
of a radiation-heating device 2 (second group of heating
element) provided in the heating furnace of Figure 1.

A plurality of heating elements of longitudinal
10 shape (nine elements in this example) ① to ⑨ are
disposed in a row to form a radiation-heating device 2.
Each of the heating elements ① to ⑨ is disposed in the
left and right direction of the central part of the glass
sheet 4 or 5 of forming a window glass for an automobile
15 in such a manner as to put the longitudinal direction of
each element in the vertical direction (horizontal
direction) of the center line C of the glass sheet 4 or
5. By this manner, a temperature distribution is formed
depending on a radiation heat from each heating element
20 along the center line C of the glass sheet 4 or 5. The
radiation-heating device 2 is provided in the vicinity of
the upper side of the glass sheet in the bending zone Z2
of the heating furnace 1. The floor heater 3 is provided
on the lower side of the glass sheet. The floor heater 3
25 also comprises a plurality of divided heating elements in
the same manner as in the radiation-heating device 2
provided on the upper side of the glass sheet, and this

is preferable for forming a temperature distribution at a higher accuracy. In this case, a distance between the glass sheet and the radiation-heating device 2 is adjusted so as to be capable of forming an aimed temperature distribution by each heating element, and is in the range of about 50 to 250 mm. A surface temperature of each heating element of the radiation-heating device 2 is controlled individually depending on each heating element in each section.

10 A bending mold having at least one glass sheet placed thereon can be accurately stayed at a predetermined position of each section in the furnace. The deepest position of the section of a glass sheet to be bended is determined by a position relationship
15 between a radiation-heating device 2 and a glass sheet 4 or 5. When a windshield glass of an automobile is designed so as to be smoothly connected with a roof part, the most deeply bended position of the section of the windshield glass is on the upper part (upper part of the windshield glass mounted on a car body). In the case of
20 such at least one glass sheet, a temperature distribution having a higher temperature at the upper part of the glass sheet can be easily formed by adjusting a position of stopping the bending mold having the glass sheet
25 placed thereon and a temperature of each heating element depending on disposition of the radiation-heating device 2 shown in Figure 2.

Figure 3 is a structure view illustrating another embodiment of a radiation-heating device 2 of the present invention.

This embodiment comprises a radiation-heating device 2 having five heating elements ① to ⑤ placed along the center line C in the central part of the inner side of a glass sheet 6.

Figure 4 is a structure view illustrating still another embodiment of a radiation-heating device of the present invention.

This embodiment comprises two heating elements a and b and two heating elements c and d respectively provided on the left side and the right side of heating elements ① to ⑨ in the central part in addition to the radiation-heating device illustrated in the above Figure 2 in order to form a temperature distribution on both side parts in the left and right direction (width (car width) direction of a window glass for an automobile) of a glass sheet 6.

Figure 5 is a sectional view illustrating an example of a radiation-heating device 2.

In this example, each of heating elements ① to ⑨ is provided on a heater rack 7 in such a manner as to make the height of the lower side face (heat-radiating face) of each heating element constant. The heater rack 7 is supported separably from the ceiling inner wall of a heating furnace.

Figure 6 is a sectional view illustrating an

embodiment wherein the disposition of each of the heating elements ① to ⑨ of the radiation-heating device 2 shown in Figure 5 is changed.

In this example, a height of each of heating elements ① to ⑨ on the heater rack 7 is made variable, and each height of each heating element is variable as compared with the embodiment illustrated in Figure 5. By adjusting the height of each heating element depending on an aimed temperature distribution to be formed on at least one glass sheet, the aimed temperature distribution can be more accurately formed. By adjusting the height of each heating element depending on an aimed shape of at least one glass sheet to be bended, a desired temperature distribution can be formed on at least one glass sheet having various shapes. Also in this example, the heater rack 7 is supported separably from the ceiling inner wall of the heating furnace in the same manner as in the example of Figure 5.

Figure 7 is a structure view of an inner part of a furnace illustrating an example of a bending apparatus of the present invention.

As shown in this Figure, a ceiling heater 8 is provided on the ceiling of a heating furnace 15 (bending zone Z2 in Figure 1). Also, a conveyer 10 is provided through each zone Z1, Z2 and Z3 in the heating furnace (see Figure 1), and a bending mold 9 is conveyed. At least one glass sheet (not shown) is placed on the

bending mold 9. A floor heater 3 is provided under the conveyor 10. In this manner, a first group of heating elements comprises the ceiling heater 8 and the floor heater 3. A radiation-heating device 2 (a second group of heating elements) is suspended in the vicinity above at least one glass sheet (not shown) on the bending mold 9. In this case, the ceiling heater 8 on the back side of the radiation-heating device 2 may be selectively used without using all of them.

Figure 8 is a structure view of an inner part of a furnace illustrating another example of a bending apparatus of the present invention. In this example, a radiation-heating device 2 comprising heating elements ① to ⑤ having various heights provided on a heater rack 7 is suspended from the ceiling of a furnace as a radiation-heating device in the same manner as in the example of Figure 6.

Figure 9 is a sectional view illustrating a preferable structure of a heating element.

A ceramic board 13 is provided on the lower side of a heater rack 7, and a heater wire 14 is embedded within the ceramic board 13. An equally heating plate 11 is fixed on the heater rack 7 by a supporting rod 12 so as to cover the lower side of the heater wire 14. By providing the equally heating plate 11, heat from the heater wire 14 makes a temperature within the equally heating plate equal, and a uniform radiation heat from

can be improved.

CLAIMS

1. A bending apparatus for bending at least one glass sheet placed on a bending mold into a desired shape by heating in a furnace, which comprises a bending mold for placing at least one glass sheet thereon, a tunnel-like heating furnace through which the bending mold is conveyed, a first group of a plurality of heating elements fixed on an inner wall of the heating furnace, and a radiation-heating device having a second group of a plurality of heating elements placed separably from the inner wall surface of the heating furnace.
2. The bending apparatus for at least one glass sheet according to Claim 1, wherein the second group of heating elements radiation-heat locally at least one glass sheet at a predetermined position to provide a predetermined temperature distribution on the glass sheet.
3. The bending apparatus for at least one glass sheet according to Claim 1 or 2, wherein the second group of heating elements are suspended from a ceiling inner wall of the heating furnace at a position opposed to the upper surface of the glass sheet.
4. The bending apparatus for at least one glass sheet according to Claim 1, 2 or 3, wherein a distance between the second group of heating elements and the inner wall surface of the heating furnace is variable.
5. The bending apparatus for at least one glass sheet according to Claim 1, 2, 3 or 4, wherein each heating

element of the second group of heating elements has a heater wire and an equally heating plate provided at the heating face side of the heater wire.

7. The method of bending at least one glass sheet
15 according to Claim 6, wherein the second group of heating
elements radiation-heat locally at least one glass sheet
to provide a predetermined temperature distribution on
the glass sheet.

9. The method of bending at least one glass sheet according to Claim 6, 7 or 8, wherein a distance between

the second group of heating elements and the inner wall surface of the heating furnace is variable to provide a predetermined temperature distribution on the glass sheet.

- 5 10. The method of bending at least one glass sheet according to Claim 6, 7, 8 or 9, wherein the bending mold having the glass sheet placed thereon is intermittently conveyed so as to stop at each section in the heating furnace.

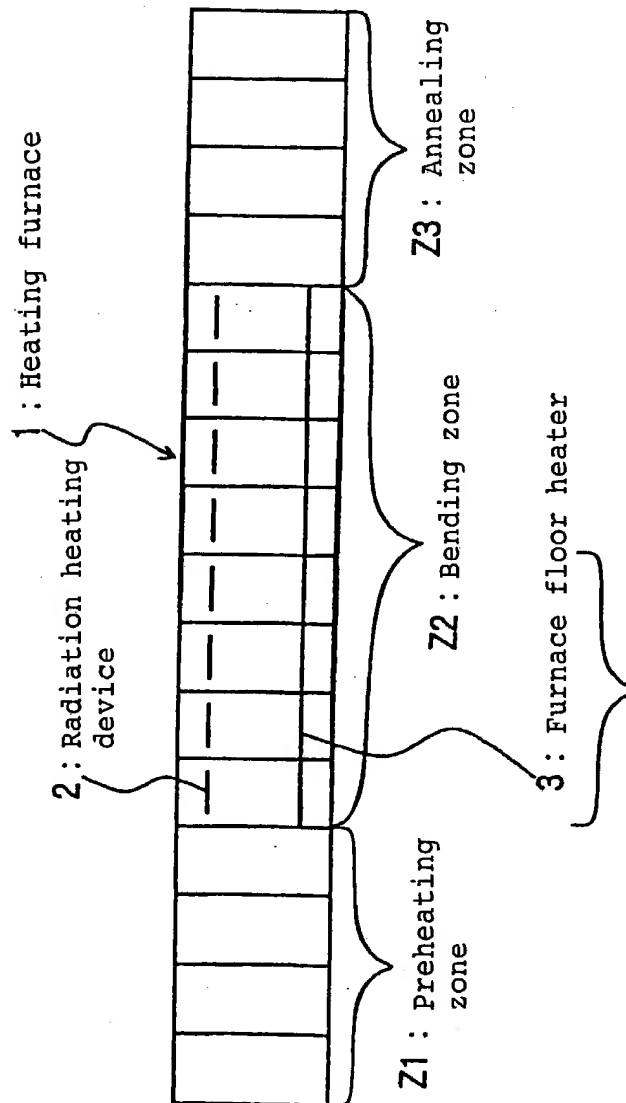
ABSTRACT

A desired temperature distribution is efficiently formed on a glass sheet by a simple structure without lowering heat efficiency within a furnace.

5 A heating furnace 15 conveys a bending mold 9 of a glass sheet and a radiation-heating device is provided in the heating furnace, and a first group of a plurality of heating elements are fixed on an inner wall surface of the heating furnace 15, and a second group of a plurality
10 of heating elements are disposed separably from an inner wall surface of the heating furnace.

1/5

FIG. 1



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2/5

FIG. 2

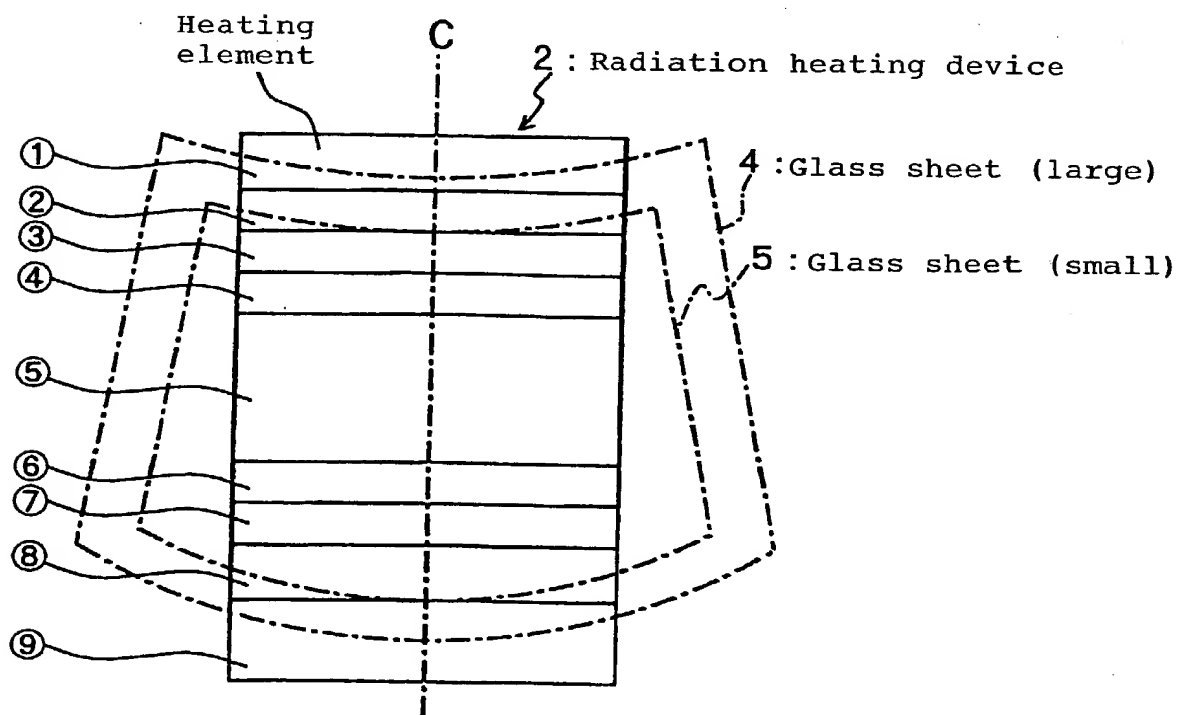


FIG. 3

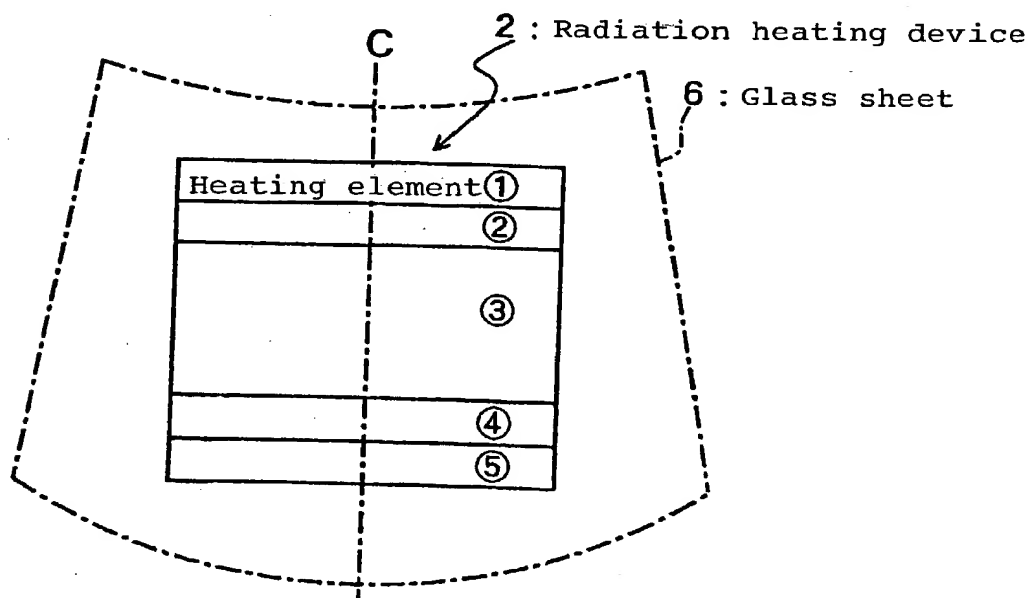


FIG. 4

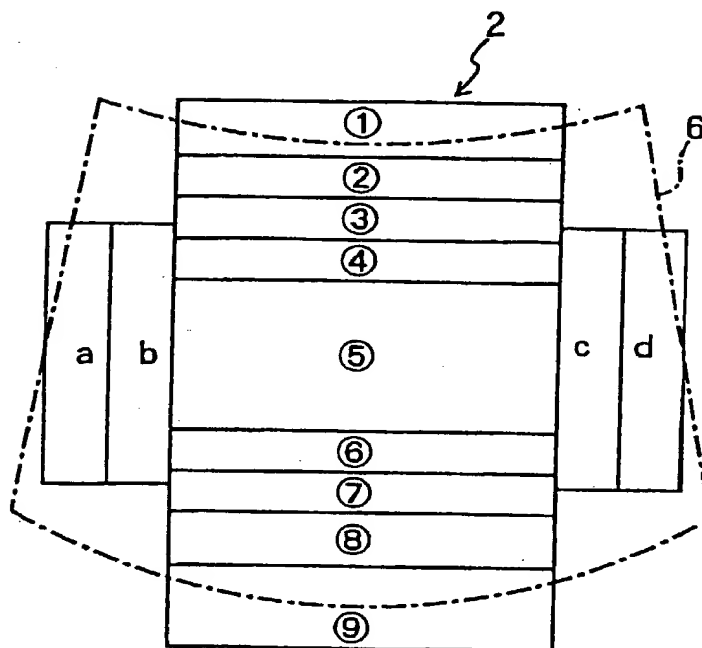


FIG. 5

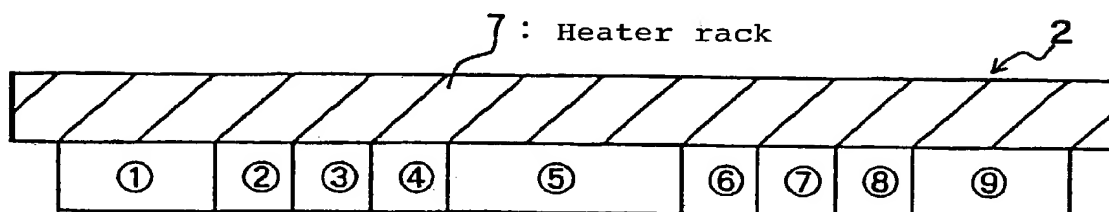


FIG. 6

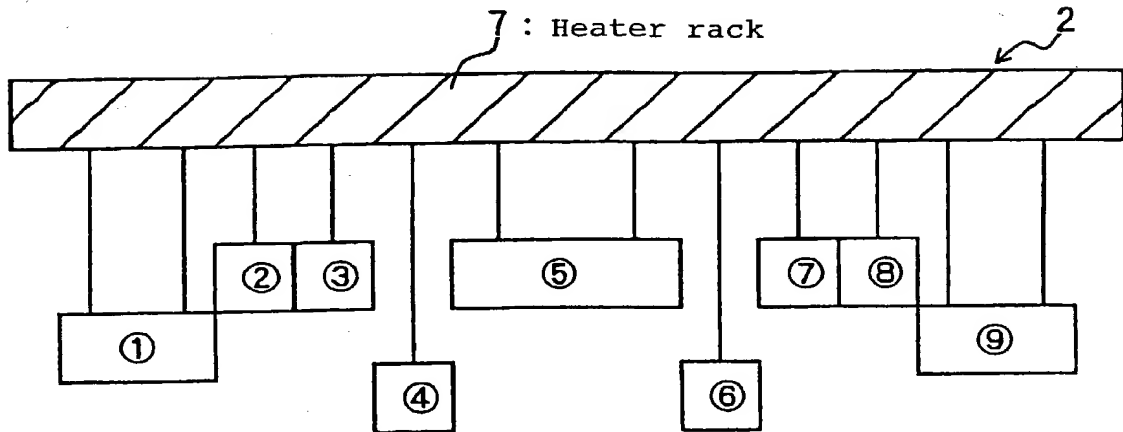
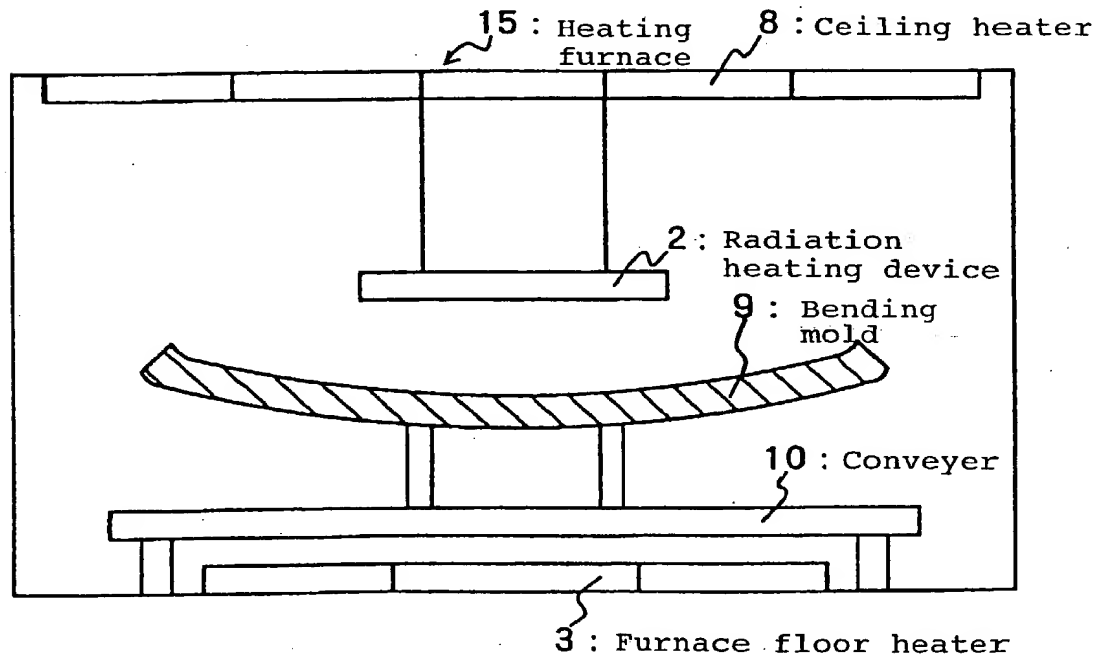


FIG. 7



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5 / 5

FIG. 8

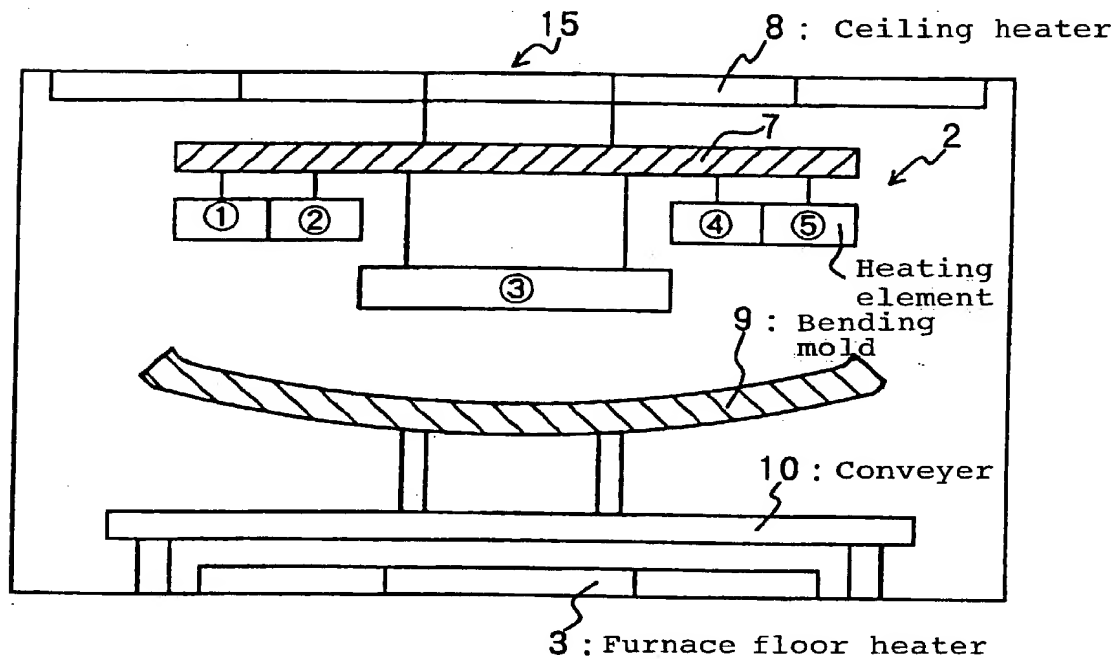
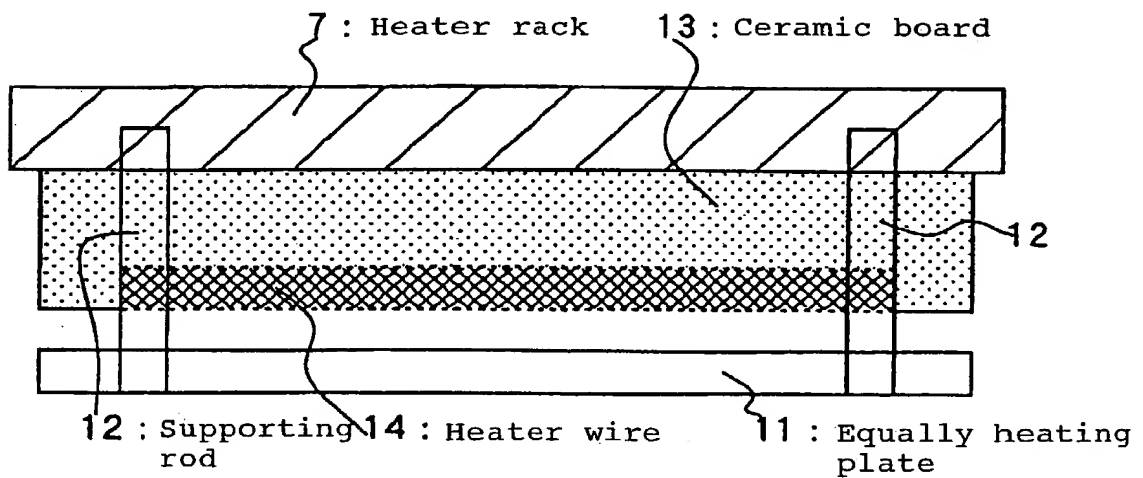


FIG. 9



日本語宣言書

Japanese Language Declaration
(日本語宣言書)

委任状：私は下記の発明者として、本出願に関する一切の手続きを米特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。
(弁護士、または代理人の指名及び登録番号を明記のこと)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: (list name and registration number)



022850

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Direct Telephone calls to: (name and telephone number)

(703) 413-3000

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国籍	Citizenship Japanese
郵便の宛先	Mailing Address Same as above

第三以降の共同発明者についても同様に記載し、署名すること)

(Supply similar information and signature for third and subsequent joint inventors.)

Japanese Language Declaration
(日本語宣言書)

委任状：私は下記の発明者として、本出願に関する一切の手続きを米特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。
(弁護士、または代理人の指名及び登録番号を明記のこと)

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Direct Telephone calls to: (name and telephone number)

(703) 413-3000

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国籍	Citizenship Japanese
郵便の宛先	Mailing Address Same as above

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国籍	Citizenship Japanese
郵便の宛先	Mailing Address Same as above

第三以降の共同発明者についても同様に記載し、署名すること)

(Supply similar information and signature for third and subsequent joint inventors.)

**Substitute
Declaration and Power of Attorney For Patent Application**

特許出願宣言書及び委任状

Japanese Language Declaration

日本語宣言書

下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

私の住所、郵便の宛先、国籍は下記の私の氏名の後に記載された通りです。

My residence, mailing address and citizenship are as stated next to my name.

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者（下記の名称が複数の場合）であると信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled.

上記発明の明細書は、

**BENDING APPARATUS FOR GLASS SHEET AND
METHOD OF BENDING GLASS SHEET**

the specification of which

☐ 本書に添付されています。

☐ is attached hereto.

☐ _____ 月 _____ 日に提出され、米国出願番号または特許協定条約国際出願番号を

☒ was filed on May 25, 2001

as United States Application Number or PCT International Application Number

_____ とし、

09/831,913 and was amended on

(該当する場合) _____ に訂正されました。

_____ (if applicable)

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

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Prior Foreign Application(s)
外国での先行出願

11-272805
(Number)
(番号)

Japan
(Country)
(国名)

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(Application No.)
(出願番号)

(Filing Date)
(出願日)

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PCT/JP00/06518
(Application No.)
(出願番号)

September 22, 2000
(Filing Date)
(出願日)

(Application No.)
(出願番号)

(Filing Date)
(出願日)

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I hereby claim foreign priority under Title 35, United States Code, § 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Priority Claimed
優先権主張

27 September 1999
(Day/Month/Year Filed)
(出願年月日)

☒ ☐
Yes No
はい いいえ

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below.

(Application No.)
(出願番号)

(Filing Date)
(出願日)

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(Status: Patented, Pending, Abandoned)
(現況：特許許可済、係属中、放棄済)

(Status: Patented, Pending, Abandoned)
(現況：特許許可済、係属中、放棄済)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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(出願番号)

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(出願日)

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(Application No.)
(出願番号)

September 22, 2000
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(出願日)

(Application No.)
(出願番号)

(Filing Date)
(出願日)

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Priority Claimed
優先権主張

27 September 1999
(Day/Month/Year Filed)
(出願年月日)

☒ ☐
Yes No
はい いいえ

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below.

(Application No.)
(出願番号)

(Filing Date)
(出願日)

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(Status: Patented, Pending, Abandoned)
(現況：特許許可済、係属中、放棄済)

(Status: Patented, Pending, Abandoned)
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住所	Citizenship
郵便の宛先	Mailing Address

(Supply similar information and signature for seventh and subsequent joint inventors.)